

atmospheres of university seminars."

Fusion is being pursued for its promise as an environmentally benign energy source. This mission orientation should not, and does not, lower its scientific standards. Indeed, the scientific progress of fusion is a subject of which we are most proud.

David E. Baldwin

Thomas C. Simonen

General Atomics,
3550 General Atomics Court,
San Diego, CA 92121-1194, USA

CO Binding and Bending Energetics

Robert F. Service (Research News, 18 Aug., p. 920) provides a lively sketch of the debate over the geometry of carbon monoxide (CO) binding to myoglobin and its importance for understanding the protein's ability to discriminate CO from O₂. While Service focuses on the conflicting structural interpretations of spectroscopic and x-ray diffraction data, I would like to highlight the argument from energetics. Because electronic forces strongly favor an upright geometry, it takes more energy to bend the Fe-CO bond significantly than the protein

can muster through steric forces. The estimation of this energy from vibrational spectroscopy (1) was one of the first of the "chinks . . . in the armor" of the bent-CO dogma.

The energy argument has an important corollary: The absence of significant bending does not mean that steric forces play no role in discriminating between CO and O₂ (2). Precisely because of CO's strong preference for upright binding, steric forces may well lower the CO affinity, even if they are not strong enough to bend the CO once it binds. Site-directed mutagenesis provides some support for this view. When the distal histidine residue, the side chain of which is positioned to interfere with upright binding, is replaced (3) by the sterically undemanding glycine, the CO affinity *increases*, by 1.0 kilocalories per mole. At the same time, the O₂ affinity *decreases*, by 1.6 kilocalories per mole, reflecting the importance of the attractive force of the hydrogen bond, mentioned by Service, between the distal histidine and the bound O₂. These changes suggest that steric repulsion of CO and H-bond attraction of O₂ are *both* important in discriminating CO from O₂. However, other influences may also be at play, including changes in the occupancy of the binding pocket by water

molecules (4). Further work is needed to delineate the various contributions to the binding energies.

Thomas G. Spiro

Department of Chemistry,
Princeton University,
Princeton, NJ 08544, USA

References

1. X.-Y. Li and T. G. Spiro, *J. Am. Chem. Soc.* **110**, 6024 (1988); G. B. Ray, X.-Y. Li, J. A. Ibers, J. L. Sessler, T. G. Spiro, *ibid.* **116**, 162 (1994).
2. J. P. Collman, J. I. Brauman, T. R. Halbert, K. S. Suslick, *Proc. Nat. Acad. Sci. U.S.A.* **73**, 3333 (1976).
3. J. S. Olson *et al.*, *Nature* **336**, 265 (1988).
4. T. Li, M. L. Quillin, G. N. Phillips Jr., J. S. Olson, *Biochemistry* **33**, 1433 (1994).

Letters to the Editor

Letters may be submitted by e-mail (at science_letters@aaaas.org), fax (202-289-7562), or regular mail (*Science*, 1333 H Street, NW, Washington, DC 20005). Letters will not be routinely acknowledged. Full addresses, signatures, and daytime phone numbers should be included. Letters should be brief (300 words or less) and may be edited for reasons of clarity or space. Beginning in October 1995, our previous policy of consulting with all letter authors before publication will be discontinued.

NEW! EndNote® Plus For Windows®



More than 85,000 users prefer
EndNote, the only Windows
bibliographic software that...

- Includes 240 journal styles
- Appends bibliographies automatically to *all* leading word processors: WordPerfect for Windows, Microsoft Word for Windows, and AmiPro
- Allows users to index all fields for high-speed searching
- Allows Macintosh and Windows users to access the same database over a network

New in Version 2.0:

- Term lists to keep track of important terms
- Global editing commands
- Enhanced searching options
- EndLink 2 (sold separately) includes 140 filters to import references from online and CD-ROM services
- Customizable EndLink import filters
- Compatible with Windows 3.1, Windows 95, and Windows NT

1 Import references

2 Store references in library

3 Select a journal style

4 Format a bibliography

Niles & Associates, Inc.
800 Jones Street
Berkeley, CA 94710
Voice: 800-554-3049
E-mail: info@niles.com
Fax: 510-559-8683
<http://www.niles.com>
Demo available at [ftp.niles.com](ftp://ftp.niles.com)

References

1. Argus, M.V. and S.I. Jones "I reflection and wing orientation of butterfly species." *J. of Entomol.* 222-36, 1994.
2. Billoski, T.V. "South and American Butterflies." (New Ed.) Butterflies, (New & Howells, 1993), pp. 97: 124-36, 1993.
3. Whiting, J.R. "Struct of butterfly wings."

Windows and the Windows logo are registered trademarks of Microsoft Corp. All other trademarks are the property of their respective companies.